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DRAFT
Characterization Report
Hull Coating Leachate

August 2003

DRAFT

CHARACTERIZATION ANALYSIS REPORT

Hull Coating Leachate

Prepared by:

Naval Sea Systems Command
U.S. Department of the Navy

Office of Water
U.S. Environmental Protection Agency

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LIST OF ACRONYMS

ASTM	American Society for Testing and Materials
CAS	Chemical Abstracts Service
CFR	Code of Federal Regulations
ChAR	Characterization Analysis Report
EPA	Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
IMO	International Maritime Organization
MESO	Marine Environmental Support Office
MPCD	Marine Pollution Control Device
MSDS	Material Safety Data Sheet
OAPCA	Organotin Antifouling Paint Control Act
ORTEPA	Organotin Environmental Programme Association
RIB	Rigid Inflatable Boat
TBT	Tributyltin
UNDS	Uniform National Discharge Standards
UNDSMIS	Uniform National Discharge Standards Management Information System
USCG	United States Coast Guard
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The purpose of the Characterization Analysis Report (ChAR) is to provide the information necessary to conduct the feasibility and environmental effects analyses. In 40 CFR Part 1700, hull coating leachate was identified as a discharge requiring control for vessels of the Armed Forces and defined hull coating leachate as "…constituents that leach, dissolve, ablate, or erode from the paint on the hull into the surrounding seawater." As such, the information addressed in this ChAR includes the chemical constituents, release rates, and release quantities of constituents discharged from the underwater hull coatings of Armed Forces vessels, and an analysis of hull coating alternatives.

Armed Forces vessels use several underwater hull coating systems. These underwater hull coating systems are divided into coatings intended to control marine fouling and coatings intended to prevent corrosion of the hull. For the purpose of hull coating leachate discharge, hulls coated with coatings that only control corrosion are not included because constituents are not released into the water from these systems. Only coatings that control marine fouling growth are included in the hull coating leachate discharge.

Fouling control coatings can be broadly grouped into two categories. The first category includes the current antifouling coatings used on Armed Forces vessels (i.e., copper-containing antifouling coatings and advanced antifouling coatings). Copper-containing antifouling coatings are complex mixtures of resins, pigments (e.g., zinc oxide, iron oxides, carbon black, etc.), thickeners, and biocides such as cuprous oxide, copper thiocyanate, or other copper compounds that serve as biocides releasing copper when exposed to seawater). Copper ablative coatings, which are designed to wear or ablate away as a result of water flow over a hull, and vinyl antifouling coatings, which release copper as a result of copper leaching and hydrolysis of rosin particles, are the most predominantly used copper-containing coatings. Advanced antifouling coatings use the short half-life, non-metallic biocide (Sea-Nine211®) to control fouling. Biocidal coatings are applied to the majority of Armed Forces vessels. The copper and zinc based biocides exhibit high efficacy against marine fouling organisms. The second category of coatings that are used to control fouling on Armed Forces vessels is categorized as foul-release coatings. Foul-release coatings, typically based on silicone resins and oils, do not contain biocides, but rely on a smooth, low energy surface to inhibit fouling organism adhesion to a ship's hull. These foul-release coatings may inhibit fouling organism adhesion to the ship's hull so effectively that the hydrodynamic drag, created by the ship moving through the water, dislodges any organisms that start to grow on the hull.

1.1 VESSEL GROUPS

To facilitate feasibility and environmental effects analyses, vessel classes that produce hull coating leachate were arranged into vessel groups according to hull material and associated antifouling coating type. A specific vessel class was selected for each vessel group to facilitate discharge analyses. A complete discussion of the methodology and rationale is discussed in the

Vessel Grouping and Representative Vessel Selection for Hull Coating Leachate Discharge (EPA and Navy, 2003c). The hull coating leachate vessel groups and vessel classes chosen to facilitate analyses are:

- Steel, Composite, and Other Non-Aluminum Rigid Hulls: USS NIMITZ (CVN 68),
- Flexible Hulls (non-aluminum): USS LOS ANGELES (SSN 688), and
- Aluminum Hulls: 47-ft Motor Lifeboat (MLB 47).

The Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group encompasses most Armed Forces vessels. There is considerable variability in size and design among vessels in this group. Vessels in this group range from small boats to aircraft carriers that are over 1,000 feet long. For the purpose of these analyses, the CVN 68 class of aircraft carrier was selected to facilitate analyses for this class because:

- as a vessel type, aircraft carriers have among the greatest wetted-hull surface area of this vessel group;
- all aircraft carriers use standard copper ablative coatings; and
- the CVN 68 Class vessels are still under construction and are expected to remain in service for decades.

Vessels with the largest surface area are anticipated to release the greatest mass of hull coating leachate because the leach rate is measured on a per unit area basis and is independent of hull substrate material.

The Flexible Hulls vessel group includes ships with underwater hulls covered by flexible elastomeric materials. The Flexible Hulls vessel group includes 58 submarines, distributed among three classes with roughly the same wetted hull area, and the MCM 14, a mine countermeasure vessel in the USS AVENGER (MCM 1) class (Mine, 2002). The SSN 688 class of attack submarines was selected as the representative vessel class for this group. This class has 51 submarines in service and comprises approximately 86% of the number of vessels in the group. Copper ablative coatings are the primary antifouling coating used on this vessel group, but these coatings crack as a result of the elastomer compressing more than the antifouling coating system when the vessel dives to operating depth. The cracking of these coatings is an ongoing maintenance issue. The Navy has active efforts to identify antifouling coatings that are more flexible for use on flexible hulls.

The Aluminum Hulls vessel group includes numerous classes of smaller vessels used by the Armed Forces. Vessels with aluminum hulls include boats and craft ranging from less than 20 feet long to 192 feet in length. Armed Forces coating policy prohibits the use of copper-containing coatings on vessels in this group. Copper-containing coatings are not used on aluminum hulls to minimize the potential for deposition corrosion at coating defects (ASM, 1987; Jones, 1992; Lamtec, 2001). More information on deposition corrosion is discussed in the *Feasibility Impact Analysis Report: Hull Coating Leachate* (EPA and Navy, 2003d). Due to this prohibition on copper-containing coatings, craft in the Aluminum Hulls vessel group are coated with either foul-release coatings or coatings that use zinc-based and/or non-metallic biocides. The USCG's most recent motor lifeboat class, the MLB 47, was selected as the representative aluminum hull vessel because it is one of the larger Armed Forces vessels with an aluminum hull, is a relatively numerous vessel class (i.e., over 71 vessels in service), and its operational parameters are consistent with the majority of aluminum craft operated by the Armed Forces.

1.2 Marine Pollution Control Device Option Groups

After evaluating various technologies, three MPCD option groups passed the initial screening process for the hull coating leachate discharge:

- Establish a maximum allowable copper release rate for antifouling coatings,
- Foul-release coatings, and
- Advanced antifouling coatings.

The following sections provide a short overview of each option group. Additional details about these option groups are included in the respectively named hull coating leachate MPCD screens (EPA and Navy, 2002, 2003a, 2003b).

1.2.1 Establish a Maximum Allowable Copper Release Rate for Antifouling Coatings

For Armed Forces vessels coated with antifouling products qualified under the military specification MIL-PRF-24647, the biocide released into the water to prevent the growth of marine fouling organisms is the copper from cuprous oxide or other copper-containing compounds included in the coatings (Navy, 2001a). This MPCD option group would establish a maximum allowable copper release rate from current and future copper-containing antifouling coatings. If this MPCD option group is chosen, it will prevent the use of higher release rate copper-containing coatings in future applications.

1.2.2 Foul-Release Coatings

The foul-release coatings MPCD option would essentially eliminate hull coating leachate by adopting the use of these silicone-based hull coatings that inherently do not release any biocidal constituents. Instead, these coatings rely on a smooth low-energy surface to inhibit the adhesion of fouling organisms to the hull and to release attached organisms when the vessel achieves a critical speed (usually in excess of 15 knots). Foul-release coatings are listed as a category in military performance specification MIL-PRF-24647, and one product of this type is approved for use on USCG and Navy vessels. Use of the currently approved foul-release coating on Armed Forces vessels is limited because foul-release coatings are far more vulnerable to damage from abrasion due to contact with fenders or tugs, scratches due to impact with ice or debris, and hull cleaning than currently approved copper-containing products. For example, foul-release coatings are used on less than 1% of Navy vessels, are not used on any submarines, and are used on fewer than 10% of USCG vessels. The environmental effects and feasibility analyses for the foul-release coatings MPCD option consider the increased use of foul-release coatings in the Armed Forces to the entire vessel group (EPA and Navy, 2003d; EPA and Navy, 2003e).

1.2.3 Advanced Antifouling Coatings

The advanced antifouling coatings MPCD option would adopt the use of a short half-life non-metallic biocide (i.e., Sea-Nine211®) to either replace copper and zinc based biocides, or may be used as a co-biocide. Short half-life non-metallic biocides are intended to control fouling at the coating surface, but degrade rapidly in the water into benign byproducts. Advanced antifouling coatings are currently being tested on Armed Forces vessels. The USCG has already approved one advanced antifouling coating that uses Sea-Nine211® to control fouling on smaller USCG vessels with aluminum hulls (USCG, 2000). The USCG-approved non-metallic biocide coating performs effectively for less than two years in areas with a high fouling growth rate (e.g., Miami, FL and Ingleside, TX). Currently, advanced antifouling coatings have not satisfied the Navy performance requirements in MIL-PRF-24647. However, advanced antifouling coatings are being tested and may satisfy the MIL-PRF-24647 requirements in the future. The Navy continues to evaluate advanced antifouling coatings and believes these coatings offer the greatest potential as a future MPCD to reduce or eliminate copper hull coating leachate. In the case of advanced antifouling coatings that use copper as a co-biocide, the Navy has stated that advanced antifouling coatings should emit less copper than is currently released from the copper-ablative products approved under MIL-PRF-24647 to be considered an environmentally acceptable product by the Navy (Ingle, 2002). This goal is to ensure that advanced antifouling coatings have a reduced environment impact when compared to currently approved copper-containing coatings.

1.3 CHARACTERIZATION DATA

For this ChAR, the Characterization Data sections present all data and information found to support the environmental effects and feasibility impact analyses. These sections are organized by vessel group with subsections for each MPCD option. If an MPCD option was determined to be not feasible for a vessel group, such a statement and justification is made and characterization data are not presented. The following sections describe the types of data that are presented in this analysis.

1.3.1 Physical Parameters

In the Physical Parameters sections of this report, vessel class information is presented. Because modeling is not being used in the environmental effects analysis, information on vessel size, underwater hull wetted area, number of vessels in the vessel group, number of days in U.S. ports, and number of days in transit between 0 nm and 12 nm of U.S. shoreline are the only physical parameters necessary for the characterization of the discharge from each vessel class (EPA and Navy, 2003e). All vessel physical parameter information was obtained from the Uniform National Discharge Standards Management Information System (UNDSMIS) database and the *Vessel Grouping and Representative Vessel Selection for Hull Coating Leachate Discharge* (EPA and Navy, 2003c).

1.3.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

The Chemical Data section of this report presents the chemical constituents in the coatings and estimated discharge for each baseline condition and MPCD option group, as well as all information obtained from available studies conducted on the coatings in each MPCD option group. These studies present constituent release rate information, harbor sampling data, and qualitative information on the effect of water temperature on copper release rates from the ablative coatings currently used on the majority of Armed Forces vessels. While several government studies have been conducted on copper release rates from ablative coatings, studies have not been conducted on foul-release, advanced antifouling, or vinyl antifouling coatings. A manufacturer of an advanced antifouling coating supplied constituent release rate information but did not supply the supporting studies that generated the release rate information. As a result of the limited data available, information on the constituents contained in each coating was obtained from coating manufacturers' material safety data sheets (MSDSs). Due to coating manufacturer confidentiality concerns and MSDS reporting requirements, a complete list of constituents was not obtained for any of the coatings. Some of the MSDSs reported a weight percentage range for each constituent. For some coatings, the maximum weight percentage was reported; but for others, the midpoint of the range was used to ensure the total weight percentage did not exceed 100%. The constituent names as well as the weight percentage of biocides and other constituents in the coating are presented in tables for each coating. Some coatings may contain constituents in their formulations that may leach, but are not intended to be, nor act as, biocides. These constituents are not included in the subsequent descriptions.

Field Information

Field information (i.e., classical data) is typically collected at the time of sampling and includes data such as temperature, pH, salinity, specific conductance, and free and total chlorine. The Hull Coating Leachate discharge has not been sampled in the UNDS program. Consequently, field information is not reported in this section of the ChAR.

Descriptive Information

Descriptive information includes color, floating materials, odor, settleable materials, turbidity/colloidal matter, and other parameters related to narrative water quality criteria. Hull coating leachate is not discharged from a pipe, but slowly released from the entire underwater hull of a vessel. Existing studies of hull coating leachate have not collected or reported such descriptive information. Descriptive information is not reported in this document. Due to the rate and nature of the constituents released, this discharge is expected to have negligible affects on parameters related to narrative water quality criteria.

1.3.3 Discharge Generation Rates for Mass Loading

This section of the report presents discharge generation rates for the constituents released in each MPCD option for the vessel group used for analysis.

1.4 UNCERTAINTY INFORMATION

As described in *Environmental Effects Analysis Guidance for Phase II Uniform National Discharge Standards (UNDS) for the Vessels of the Armed Forces* (EPA and Navy, 2000a), an assessment of the uncertainty of data collected, assumptions, estimations, and calculations should be made. The ChAR is the basis for the environmental effects analysis and includes an uncertainty discussion. This section of the report addresses any uncertainty associated with the assumptions, data, estimates, and calculations. Uncertainty information will be addressed for the baseline discharge and for each MPCD option group.

2.0 STEEL, COMPOSITE, AND OTHER NON-ALUMINUM RIGID HULLS

The Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group is the largest group of the three selected vessel groups for this discharge. This vessel group contains over 2,600 vessels, which is approximately 85% (by number) of all Armed Forces vessels that produce the hull coating leachate discharge. The total underwater hull wetted area for this vessel group is 2.5×10^7 ft^2, which is 91% of the total underwater hull wetted area for all Armed forces vessels that contribute to this discharge.

The vessels in the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group range from boats less than 55 feet in length to aircraft carriers that are more than 1000 feet long. Although vessels in this group vary considerably in size and design, they primarily use copper-containing antifouling coatings. The USS NIMITZ (CVN 68) class was selected as the vessel class on which to conduct analyses for this group because aircraft carriers have the largest underwater hull surface area of any Armed Forces vessel and produce the greatest constituent mass loading. In addition, the CVN 68 class is representative of the larger Navy ships that are extending their drydocking cycles from 5-7 years to approximately 12 years.

2.1 BASELINE DISCHARGE

Vessels in this group use one of several similar copper-containing hull coatings that release copper into the water as a result of cuprous oxide particle dissolution. To ensure a constantly refreshed supply of cuprous oxide particles at the coating surface, the overall paint system ablates or wears away. These coatings have a relatively long service life when compared to other coatings (i.e., foul-release and advanced antifouling coatings) and are the only currently available coatings capable, with supplementary hull cleanings, of supporting a 12-year drydocking cycle. These coatings are durable and can be used on all vessels types except vessels with aluminum hulls.

The baseline discharge for this vessel grouping includes constituents from the copper ablative antifouling coatings qualified to military specification MIL-PRF-24647, vinyl antifouling coatings manufactured to military specification MIL-P-15931, or the ablative coatings specified in contracts for use on Armed Forces vessels (e.g., Military Sealift Command vessels use copper ablative coatings not qualified to Navy specifications). Vessels in this group typically use the following copper-containing antifouling coating systems:

- Ameron ABC #3,
- International BRA640,
- Ameron ABC #4,
- Hempel Olympic 7660, and
- International 4050 (i.e., vinyl antifouling coating, Formula 121 of MIL-P-15931).

It is estimated that 86% of the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group is coated with a copper ablative antifouling coating (i.e., ABC #3, BRA640, ABC #4, and

Olympic 7660) and 14% is coated with vinyl antifouling coatings (i.e., Formula 121) (Shimko and Tock, 2003). Ameron ABC #3 and International BRA640 are the most predominately used and studied copper ablative antifouling coatings. It is assumed that 50% of vessels using copper ablative coatings are coated with Ameron ABC #3 and the remaining 50% are coated with International BRA640. To facilitate estimations for a fleet coated with two different coatings, the constituent information from each of the two coatings were averaged and the average information was used to serve as the baseline coating information in the analyses. The remaining 14% of vessels are coated with vinyl antifouling coatings (i.e., Formula 121). Information on the other hull coatings used by the Armed Forces was collected and is included in Appendix A.

2.1.1 Characterization Data

Hull coating leachate discharge is the result of constituents being released from antifouling coatings. Studies conducted by the Navy and information supplied by coating manufacturers were used to characterize these coatings and the resulting discharges.

2.1.1.1 Physical Parameters

The CVN 68 class hull is steel as are the majority of the hulls of the vessels in this vessel group. The CVN 68 class currently includes ten vessels. Each vessel is 1,040 ft long and has an underwater hull area of 159,500 ft^2 (Navy, 1992). CVN 68 class vessels are in U.S. ports for an average of 147 days per year and in transit between 0 nm and 12 nm of the U.S. shoreline approximately three days per year (EPA and Navy, 1999).

2.1.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

<u>Composition of Coatings</u>

The initial step taken to characterize the hull coating leachate discharge was to identify constituents present in the coatings and their relative quantities. MSDSs were obtained for each coating in this option group. MSDSs do not list all coating constituents, but all biocides and hazardous materials are required by law to be reported by the coating manufacturer. Therefore, only constituents listed in each coating's MSDS are addressed. MSDS reporting requirements permit the ingredient quantities to be listed as a possible range or a maximum value to protect a company's confidentiality. Some of the coatings' MSDSs reported a maximum value for the constituent information and the maximum value was used for the constituent weight percentage.

As previously stated, 86% of vessels in the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group are coated with copper ablative coatings. The two most commonly used coatings are Ameron ABC #3 and International BRA640. The MSDS constituent information for Ameron ABC #3 and International BRA640 is presented in Tables 2-1 and 2-2, respectively.

Table 2-1. Constituents for Ameron ABC #3 (Red)

Constituent	Approximate Coating Weight % from MSDS
Cuprous oxide	50
Zinc oxide	20
Butyl alcohol	9.7
Xylene	5.9
Polyamide resin	5.0
Plasticizer	5.0
Ethyl benzene	1.4

Source: Ameron MSDS for ABC #3 (Ameron, 2002a).
-The MSDS reported the weight percentage to be is less than or equal to these values.

Table 2-2. Constituents for International BRA640 (Red)

Constituent	Approximate Coating Weight % from MSDS
Cuprous oxide	38
Zinc oxide	18
Rosin	18
N-butyl alcohol	5.5
Ethyl benzene	5.5
Iron oxide	5.5
Xylenes (o-, m-, and p- isomers)	5.5
N-ethyltoluenesulfonamide (plasticizer)	5.5

Source: International MSDS for BRA640 (Red) (International, 2002a).
- The MSDS reported a weight percentage range. The constituent weight percentage presented in the table is the midpoint of the range.

The constituent values from ABC #3 and BRA640 were averaged to generate constituent information for the baseline copper ablative coating that is shown in Table 2-3 (refer to section 2.1 for assumptions and reasoning). The plasticizers used by ABC #3 and BRA640 were identified by different Chemical Abstracts Service (CAS) Registry numbers. Therefore, these constituents remain identified as separate entities in Table 2-3.

Table 2-3. Constituents for the Baseline Copper Ablative Coating in the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

Constituent	Estimated Weight % in Baseline Coating
Cuprous oxide	44
Zinc oxide	19
Rosin	8.8
N-butyl alcohol	7.6
Xylenes (o-, m-, and p- isomers)	5.7
Ethyl benzene	3.5
N-ethyltoluenesulfonamide (plasticizer)	2.8
Iron oxide	2.8
Polyamide resin	2.5
Plasticizer	2.5

The remaining 14% of vessels in the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group use vinyl antifouling coatings to coat hulls. These coatings are not ablative, but release copper slowly by leaching through a porous matrix that is produced by hydrolysis of rosin. Table 2-4 presents the MSDS constituents listed for vinyl antifouling coatings (i.e., Formula 121).

Table 2-4. Constituents for Vinyl Antifouling Coatings (i.e., Formula 121)

Constituent	Approximate Coating Weight % from MSDS
Cuprous oxide	63
Rosin	18
Methylisobutyl ketone	5.5
Xylenes (o-, m-, and p- isomers)	5.5
N-ethyltoluenesulfonamide (plasticizer)	5.5
vinyl chloride-vinyl acetate copolymer	5.5
Ethyl benzene	0.6

Source: MSDS for International 4050 (International, 2002c).
- The MSDS reported a weight percentage range. The constituent weight percentage presented in the table is the midpoint of the range.

Constituent Release Rates

In 1997, the Navy's Marine Environmental Support Office (MESO) reported test results of panels painted with the copper ablative coatings, ABC #3 and BRA640, conducted in San Diego Bay over a period of three to five years. Static testing was conducted using stationary steel panels to simulate pierside conditions. As part of the static test procedure (Lindner, 1993), 10 by 12 inch steel panels were coated on both sides with the test paints. These panels were then inserted vertically into PVC frames and suspended from the floating platform 3 feet below the water surface for a 2 or 3 month period. Rotating steel drums were used for dynamic testing to simulate underway conditions. Copper ablative coatings were applied to both sides of the 3 by 7 inch steel panels (88 steel panels per drum). The steel panels were then attached to a plastic drum 18 inches in diameter by 36 inches long and immersed in seawater 3 feet below the water surface. The drum was then mechanically rotated at a peripheral velocity of 17 knots to simulate ship movement through water. One month of rotating the drums in a dynamic cycle was followed by a one month static (stationary) cycle. After 39 months, the test protocol was changed to two months of static and one month of dynamic exposure. Release rates for copper and zinc were generated from this study (MESO, 1997; EPA and DoD, 1998).

Using the release rates from the MESO report and MSDS constituent information, the release rates for all constituents listed in the baseline coating were estimated. For solvents, the volatile organic compounds (VOCs) used in the coating (e.g. xylene, butyl alcohol, etc.) act as simple carriers and are assumed to evaporate out of the coating before the vessel is placed in the water. This assumption is valid for antifouling coatings because the purpose of the solvent is to reduce coating viscosity such that the coating can be applied (i.e., typically by spray, brush, or roller). The coating "dries" based on simple solvent evaporation (i.e., there are no chemical reactions involving the solvents). Antifouling coatings are allowed to air dry for at least 24 hours before a ship is placed in the water. This time period allows solvent evaporation out of the coating and minimizes the amount of solvent that could be released into the water. The assumptions related to biocide release rates are based on the inherent consistency of the coating and coating ablation rate. Because the ratio of the copper and zinc-containing compounds in an ablative coating are consistent throughout the coating thickness and the coatings ablate, or decrease in thickness, at a uniform rate, the release rate of the copper and the zinc compounds is assumed to be directly related to the ratio of the weight percentages of these compounds in the coating. For example, if an ablative coating contained twice as much copper by weight than zinc, the release rate of copper would be assumed to be twice the release rate of the zinc. The use of these ratios resulted in following formula:

$$\textit{Constituent (A) Release Rate} = \left(\frac{Constituent\,(A)\,wt\,\%}{Copper\,wt\,\%} \right) \times Copper\ Release\,Rate$$

Calculations were performed using the dry weight composition of the coating (i.e., removing the solvent quantities when calculating the constituent weight percentage). The estimated release rates for constituents in the baseline copper ablative coating are listed in Table 2-5. The ablative coatings and vinyl antifouling coatings (i.e., Formula 121) release constituents as dissolved metallic species and as particulates (e.g., a "chunk" of antifouling paint dislodges as the result of ablation). Therefore, release rates are measured as total metals through analytical testing and are presented as such for all release rate data presented in the ChAR.

Table 2-5. Static and Dynamic Release Rates for the Baseline Copper Ablative Coating

Constituent Name	Dynamic Release Rate [(μg/cm^2)/day]	Static Release Rate [(μg/cm^2)/day]
Total Copper	17[a]	8.9 [a]
Total Zinc	6.7 [a]	3.6 [a]
Rosin	3.8	1.6
N-ethyltoluenesulfonamide (plasticizer)	1.2	0.52
Polyamide resin	1.1	0.47
Plasticizer	1.1	0.47
Total Iron	0.84	0.44
N-butyl alcohol[b]	0.0	0.0
Xylenes (o-, m-, and p- isomers)[b]	0.0	0.0
Ethyl benzene[b]	0.0	0.0

[a]-Source: 1997 MESO Study (MESO, 1997).
[b]-VOCs are estimated to not be present in the cured coating.

Although vinyl antifouling coatings are not ablative, the release rates were estimated using the equation shown previously. Vinyl antifouling coatings are not amenable to the existing test methods for estimating release rates from ablative coatings. Studies using ablative-type methods have produced widely varied results. In 1999, the *European Coatings Journal* published average total copper release rates for vinyl antifouling coatings ranging from 2 to 202 μg/cm^2/day (Arias, 1999). The total copper release rate estimated for vinyl antifouling coatings from the previously stated equation is in the published range and is present in Table 2-6 along with constituents in vinyl antifouling coatings.

Table 2-6. Static and Dynamic Release Rates for Vinyl Antifouling Coatings

Constituent Name	Dynamic Release Rate [(μg/cm^2)/day]	Static Release Rate [(μg/cm^2)/day]
Total Copper	22	12
Ethyl Benzene[a]	0.0	0.0
Methylisobutyl Ketone[a]	0.0	0.0
Xylenes (o-, m-, p- isomers)[a]	0.0	0.0
N-Ethyltoluenesulfonamide (plasticizer)	2.2	1.1
Rosin	6.9	3.7
vinyl Chloride-vinyl Acetate Copolymer	2.2	1.1

[a]-VOCs are estimated to not be present in the cured coating.

In 2002, the MESO conducted another study to provide copper release rates for International BRA640. During this study, seawater samples were gathered at varying distances from the hull of the USS RENTZ (FFG 46) and analyzed to determine total and dissolved copper concentrations. FFG 46 was coated with BRA640 and a number of small (10’x10’) test patches of advanced antifouling coatings. These patches are relatively small and are distributed along the hull. Sampling locations were selected such that the measurements near the hull were generated aft of the test patches and adjacent to the Navy approved BRA640 antifouling coating. Three replicate samples were collected at each sampling location of 1 cm, 10 cm, 1 m, 10 m, and 80 m from the hull (MESO, 2002). A geometric mean was calculated for each set of replicate samples at each distance. The FFG 46 data are presented in Table 2-7. According to MESO, the 80 m value of 4.7 µg/l is in the range of background measurements within the Naval station pier areas.

Table 2-7. USS RENTZ (FFG 46) Total Copper Data

Distance from Hull	Geometric Mean of Total Copper Concentration (µg/l)
1 cm	10
10 cm	7.3
1 m	6.0
10 m	4.3
80 m	4.7

Source: 2002 MESO Study (MESO, 2002).

Recognizing the reduction in concentration with distance from the hull is fundamentally a diffusion phenomena, solutions to basic diffusion equations were evaluated for correlation with the Table 2-7 data. The equation showing the highest correlation to the FFG 46 data points is a simplified derivation of the Streeter-Phelps equation (Benoit, 2002):

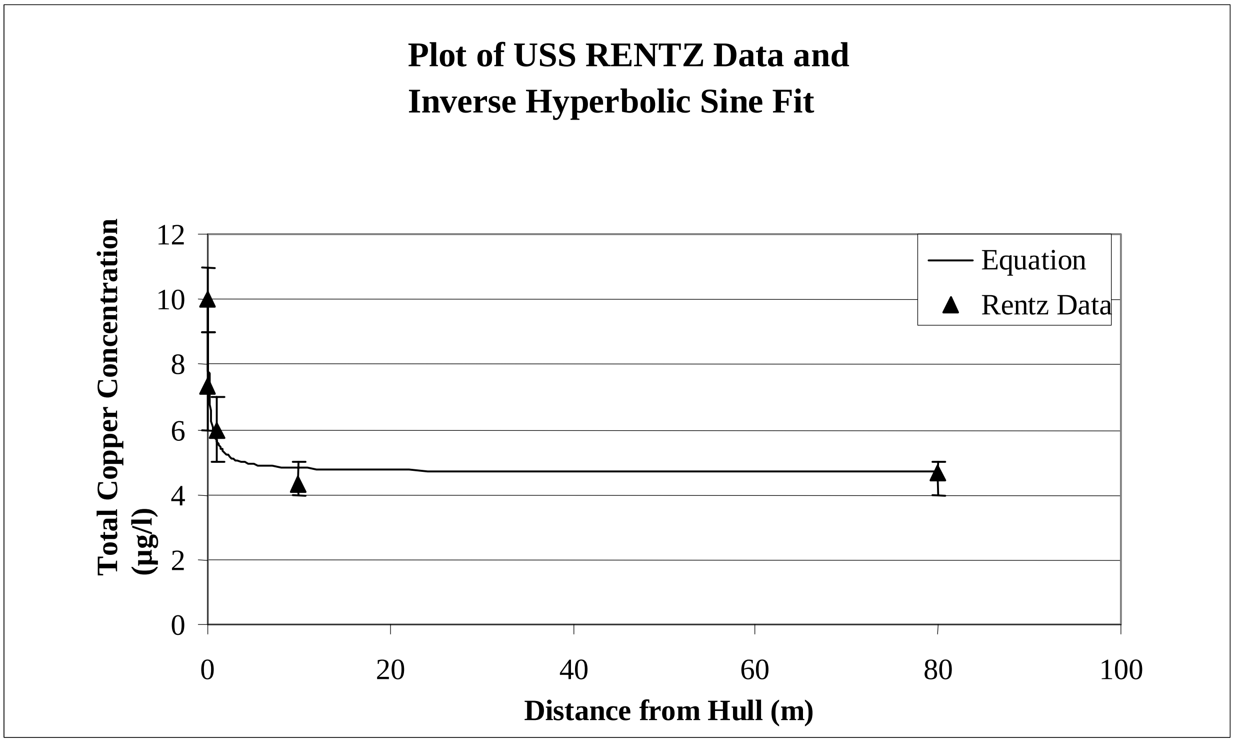
$$y = 1.4 \sinh^{-1}\left(\frac{1.2}{x}\right) + B$$

where:

y = Concentration in µg/l,
x = Distance from the hull in meters (for x>0.01 m), and
B = Background Concentration in µg/l (i.e., 4.7µg/l).

Figure 2-1 shows the USS RENTZ (FFG 46) data and the plot of the equation shown above.

Figure 2-1. USS RENTZ Total Copper Data



The equation is used to calculate concentrations at 1 cm and 35 m from the hull for the environmental effects analyses. The concentration at 1 cm is used for the end-of-pipe analysis. The concentration at the 35 m edge of the mixing zone is used to perform the discharge toxicity calculations.

To estimate the concentration of other identified constituents at 1 cm and 35 m, an assumption was made that the static release rate of a constituent corresponds to a concentration at a specific distance with the following equation:

$$\text{Concentration at } X\text{ m} = \left(\frac{\text{Copper Conc. at } X\text{m}}{\text{Copper Static Release Rate}}\right) \times \text{Constituent Static Release Rate}$$

The constituent concentrations at 1 cm and 35 m from the hull for copper ablative coatings and vinyl antifouling coatings are calculated using the above equation and are listed in Tables 2-8 and 2-9, respectively.

Table 2-8. Concentration of Constituents Released from Copper Ablative Coatings

Constituent Name	Concentration with Removal of Background Level (µg/l)	
	1 cm	35 m
Total Copper	5.3	3.3×10^{-2}
Total Zinc	2.1	1.3×10^{-2}
Rosin	1.0	6.1×10^{-3}
N-ethyltoluenesulfonamide (plasticizer)	0.31	1.9×10^{-3}
Polyamide resin	0.28	1.7×10^{-3}
Plasticizer	0.28	1.7×10^{-3}
Total Iron	0.26	1.6×10^{-3}
N-butyl alcohol[a]	0.0	0.0
Xylenes (o-, m-, and p- isomers)[a]	0.0	0.0
Ethyl benzene[a]	0.0	0.0

[a]-VOCs are estimated to not be present in the cured coating.

Table 2-9. Concentration of Constituents Released from Vinyl Antifouling Coatings

Constituent Name	Concentration with Removal of Background Level (µg/l)	
	1 cm	35 m
Total Copper	6.8	4.3×10^{-2}
Ethyl Benzene[a]	0.0	0.0
Methylisobutyl Ketone[a]	0.0	0.0
Xylenes (o-, m-, p- isomers)[a]	0.0	0.0
N-Ethyltoluenesulfonamide (plasticizer)	0.68	4.3×10^{-3}
Rosin	2.2	1.4×10^{-2}
Vinyl Chloride-vinyl Acetate Copolymer	0.68	4.3×10^{-3}

[a]-VOCs are estimated to not be present in the cured coating.

Field Information

Field information for coatings in the baseline discharge was not generated as part of the UNDS data collection process.

Descriptive Information

Descriptive information is not available for coatings in the baseline discharge. As previously stated, hull coating leachate is not discharged from a pipe but slowly released from the entire underwater hull of a vessel. Due to the rate and nature of the constituents released, this discharge is expected to have negligible affects on parameters related to narrative water quality criteria. In addition, constituent concentrations at the 35 m edge of mixing zone are shown to approach background levels. Therefore, it is deduced that antifouling coatings do not produce a meaningful effect on color, floating materials, odor, settleable materials, taste, or turbidity/colloidal matter in receiving waters.

2.1.1.3 Discharge Generation Rates for Mass Loading

The mass loading rates are estimated for the ten vessels that are listed in the CVN 68 class. A complete list of Steel, Composite, and Other Non-Aluminum Rigid Hulls vessels is included in the *Vessel Grouping and Representative Vessel Selection for Hull Coating Leachate Discharge* (EPA and Navy, 2003c). To calculate generation rates for the vessel class, all ten CVN 68 class vessels were considered. Static release rates were used for in port estimates and dynamic release rates were used for underway estimates. Only total copper and total zinc generation rates are presented because these are the only constituents of concern in currently approved, copper-containing antifouling coatings. Total copper and total zinc generation rates are calculated assuming an 86% use of the baseline copper ablative coating and a 14% use of vinyl antifouling coatings. Tables 2-10 and 2-11 present the estimated generation rates for total copper and total zinc, respectively, for the CVN 68 vessel class. A full listing of vessel classes and characteristics for calculating generation rates and mass loadings are included in Appendix B.

Table 2-10. CVN 68 Vessel Class Estimated Generation Rates for Total Copper

Class	Number of Vessels	Days In Port	Days in Transit (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (kg Cu/day)			Annual generation rate per class (kg Cu/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
CVN 68	10	147	3	215	1.4	2.7	2.7	2.1×10^3	81	5.8×10^3

Note: This analysis includes the CVN 76 and CVN 77, neither of which is commissioned. The calculation does not account for a vessel's time in drydock.

Table 2-11. CVN 68 Vessel Class Estimated Generation Rates for Total Zinc

Class	Number of Vessels	Days In Port	Days in Transit (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (kg Zn/day)			Annual generation rate per class (kg Zn/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
CVN 68	10	147	3	215	4.5×10^{-1}	8.5×10^{-1}	8.5×10^{-1}	6.7×10^2	26	1.8×10^3

Note: This analysis includes the CVN 76 and CVN 77, neither of which is commissioned. The calculation does not account for a vessel's time in drydock.

2.1.2 Uncertainty Information

Uncertainty exists in the estimation of release rates for coating constituents. The copper and zinc release rates obtained from a MESO report were based on testing conducted in San Diego Bay. Release rates have been shown to be affected by a variety of factors (e.g., temperature, pH, age of coating) (Lindner, 1993). Therefore, the release of copper and zinc is expected to vary with these factors.

A second source of uncertainty is introduced when estimating the release rates of other coating constituents. The release rates for other coating constituents were estimated based on their weight percentage relative to copper. The assumption that release rates are proportional to coating composition has not been verified. Further, the weight percentage was estimated, based on MSDS information, for each constituent. In many cases, MSDSs only listed a range and not a specific value for a particular constituent. In some cases, a maximum value of the range was used, while in other cases, the midpoint of the range was used.

2.2 ESTABLISH A MAXIMUM ALLOWABLE COPPER RELEASE RATE FOR ANTIFOULING COATINGS

This MPCD option group is similar to the baseline discharge. Additional characterization and calculations are not necessary. As described in Section 2.1, static and dynamic field testing was used to characterize the discharge from the “Establish a Maximum Allowable Copper Release Rate for Antifouling Coatings” MPCD.

A numerical maximum allowable copper release rate standard would be based on the results of ongoing Navy testing using the American Society for Testing and Materials (ASTM) D 6442, *Standard Test Method for Copper Release Rates of Antifouling Coating Systems in Seawater*, a laboratory test method. The laboratory copper release rate values generated using the ASTM D 6442 test method do not correlate with the measured field release rates from the FFG 46 hull studies. The ASTM D 6442 test method specifically states “This test method has not yet been validated to reflect in-situ copper release rates for antifouling products and therefore should not, at present, be used in the process of generating environmental risk assessments. In-service release rates of antifouling coatings are expected to vary with natural variability in seawater chemistry, temperature, and hydrodynamic regime” (ASTM, 2000). The ASTM D 6442 test method was developed as a laboratory test method to rapidly produce data that could be used to compare copper release rates from similar coating systems. The ASTM test method uses closely controlled temperatures, pHs, and other test parameters such that reproducible results used for qualification and registration of antifouling products are generated. The ASTM test method was never intended to reflect the actual copper leach rate from coatings on ships for multi-year periods in waters with widely varying pH, temperature, and salinity. Thus, the ASTM D 6442 test method copper release rate results cannot be compared with the observed field release rates from the FFG 46.

2.3 FOUL-RELEASE COATINGS

Foul-release coatings form smooth, low-surface energy layers on a ship hull that inhibits the ability of fouling organisms to adhere to the hull (NRL, 1997). These systems control fouling by using the shearing forces created when a vessel moves through the water to dislodge fouling organisms from the hull. Foul-release coatings do not release biocides into the water and, consequently, can foul if a ship remains inactive for an appreciable period. As little as two weeks of vessel inactivity in areas that experience rapid growth of fouling organisms can result in the build-up of marine growth on a hull coated with a foul-release coating (International, 2001). If fouling organisms are not dislodged as a result of normal vessel operations, the foul-release coatings can be cleaned using soft brushes or rags. Unfortunately, even the most careful cleaning of the soft, foul-release coatings can result in coating scratches and damage exposing the epoxy coating system primer. Once a scratch exposes the epoxy primer or the hull substrate, fouling organism grow in these areas during periods of vessel inactivity and cannot be dislodged without using aggressive brushing or scraping. The aggressive brushing or scraping then creates more scratches and the functionality of the foul-release coating rapidly degrades. The net effect of these scratch/cleaning cycles is rapid degradation in the performance of the foul-release coating. Experience on Navy and USCG craft indicate the service life of a foul-release coating is three years or less, which is a major impediment to widespread use of foul-release coatings. For additional information about foul-release coatings, see the *Hull Coating Leachate MPCD Screen, MPCD Option Group: Foul-Release Coatings*, and the *Feasibility Impact Analysis Report: Hull Coating Leachate* (EPA and Navy, 2003b; EPA and Navy, 2003d).

2.3.1 Characterization Data

Characterization of foul-release coatings and the resulting leachate is presented in the following sections. The only foul-release coating approved for use on Armed Forces vessels is International Intersleek 425. Information supplied by the manufacturer and the U.S. Environmental Protection Agency (EPA) regarding composition of the material are used as the basis for this analysis (International, 2002c; EPA, 1985).

2.3.1.1 Physical Parameters

The physical parameters of the vessel group do not change among MPCD option groups. The CVN 68 class physical parameters are presented in Section 2.1.1.1.

2.3.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

The coating constituents for International Intersleek 425 are presented in Table 2-12.

Table 2-12. Constituents for International Intersleek 425

Constituent[a]	Approximate Coating Weight % from MSDS[a]
Ethyl benzene	11
Titanium dioxide	11
Xylenes (o-, m-, and p- isomers)	11

[a]Source: International Intersleek 425 MSDS (Intersleek, 2002c).
- The MSDS reported a weight percentage range. The constituent weight percentage presented here is the maximum value.
- The MSDS did not report information regarding the balance of constituents. The remaining percentage of coating constituents may include silicon, resins, oils, pigments, and fillers.

Information from International Coatings and EPA letters regarding registration of the Intersleek 425 product indicates that none of the constituents identified in Table 2-12 are released into the water. For example, International Coatings referenced a letter from the EPA that states EPA registration was not necessary for this particular coating because "the paint acts solely through a physical or mechanical means" (EPA, 1985). Foul-release coatings are exempt from reporting under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (Public Law 95-396), because no biocides are used to control biofouling. The release of any other constituents that may be present in Intersleek 425 is expected to be negligible. As previously stated for copper-containing coatings, the solvent included in the constituent list is released during the application and curing of the coating.

Field Information

Field information for foul-release coatings is not required and was not generated as part of the UNDS program.

Descriptive Information

Descriptive information was not collected as part of the UNDS program for foul-release coatings. Due to the rate and nature of the constituents released, this discharge is expected to have negligible affects on parameters related to narrative water quality criteria (i.e., descriptive information).

2.3.1.3 Discharge Generation Rates for Mass Loading

The release rates of constituents from International Intersleek 425 are estimated to be negligible. Therefore, generation rates for this coating are assumed to be zero.

2.3.2 Uncertainty Information

Foul-release coatings are not designed to release constituents and do not contain biocides. No studies have been conducted identifying or quantifying constituents released from foul-release coatings.

2.4 ADVANCED ANTIFOULING COATINGS

Virtually all major marine-paint vendors market an advanced antifouling coating that contains copper and some form of non-metallic biocide. The advanced antifouling coatings are expected to replace TBT-based paints on commercial ships in advance of the International Maritime Organization's proposed prohibition on the use TBT-based antifouling paints by 2008 (IMO, 2003).

Given the high level of commercial interest in advanced antifouling coatings, there are numerous formulations containing metallic and non-metallic biocides. For the purpose of this analysis, only the advanced antifouling coating approved for use by the USCG will be evaluated. The USCG has approved one advanced antifouling coating, *E Paint SN-1*, for use on smaller USCG aluminum hulled vessels. *E Paint SN-1* contains zinc oxide and the patented non-metallic biocide Sea-Nine211®.

2.4.1 Characterization Data

Characterization of advanced antifouling coatings and the resulting discharge is presented in the following sections. The advanced antifouling coating *E Paint SN-1* is the basis for all calculations. Information supplied by both the E Paint Company and the EPA is the basis for all the analyses.

2.4.1.1 Physical Parameters

The physical parameters of the vessel group do not change among MPCD option groups. The CVN 68 class physical parameters are presented in Section 2.1.1.1.

2.4.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

<u>Composition of Coating</u>

The coating constituents for *E Paint SN-1* are presented in Table 2-13.

Table 2-13. Constituents for E Paint Company *E Paint SN-1*

Constituent[a]	Approximate Coating Weight % from MSDS[a]
Zinc oxide	36
Ethyl benzene	21
Sea-Nine211® (4,5-dichloro-2-n-octyl-4-isothiazolin-3-one)	3.0
Xylene	1.9
Toluene	1.2

[a]Source: E Paint Company MSDS for *E Paint SN-1* (E Paint, 2002).
- The MSDS did not report information regarding the balance of constituents. The remaining percentage of coating constituents may include silicon, resins, oils, pigments, and fillers.

<u>Constituent Release Rates</u>

The E Paint Company supplied the release rate for Sea-Nine211® (EPA, 2001) but did not provide release rates for other constituents. The E Paint Company claims that the Sea-Nine211® biocide in this coating is released by chemical reaction with seawater and is not dependent on ship motion to polish or ablate the material. Therefore, dynamic and static release rates are not applicable. Further, E Paint Company indicated that no other constituent is an active ingredient and that the zinc oxide is a pigment encased in the coating and is not released (E Paint, 2003a). EPA considers zinc oxide to be a biocide in this formulation . Based on the latest *E Paint SN-1* product data sheet, the *E Paint SN-1* coating is considered a copper and tin-free ablative matrix vehicle coating (E Paint, 2003b). Given the different explanations and terms associated with the functionality of the *E Paint SN-1*, the Navy reviewed panel test data from this coating (Lawrence, 2003). The waterline test panel data indicated that the coating experienced some wear or ablation. Based on these Navy observations, the following analysis assumes that the zinc oxide is released through the ablative process similar to the baseline discharge discussion. As previously discussed in the baseline discharge discussion, solvents used in the coating to reduce viscosity during application are evaporated before the vessel is placed in the water.

Based on these assumptions and the equation in Section 2.1.1.2 for estimating release rates, the estimated release rates of constituents from the advanced antifouling coating *E Paint SN-1* are shown in Table 2-14.

Table 2-14. Release Rates for E Paint Company *E Paint SN-1*

Constituent	Release Rate [(µg/cm^2)/day]
Sea-Nine211® (4,5-dichloro-2-n-octyl-4-isothiazolin-3-one)	1.8 [b]
Zinc oxide	17
Ethyl benzene[a]	0.0
Xylene[a]	0.0
Toluene[a]	0.0

[a]- VOCs are estimated to not be present in the cured coating.
[b]- Average leaching rate measured by ASTM Standard Test Method D 5108-90.

The biocide Sea-Nine211® exhibits a short half-life in the marine environment and degrades into less hazardous byproducts in less than one hour (Rohm and Haas, 2003). Due to the short half-life, studies showing the concentrations of Sea-Nine211® at varying distances from the hull were not available, because the product degrades before it can be sampled and the sample analyzed. To provide an estimate of the concentrations of Sea-Nine211® in the water around a ship, the assumption was made that that the Sea-Nine211® follows a similar diffusion pattern as the copper from a copper ablative coating. This assumption may result in an overestimate of concentrations; because copper is known as a persistent biocide, whereas Sea-Nine211® has a short half-life and is considered non-persistent.

Using the copper information presented in Section 2.1.1.2 and the known Sea-Nine211® release rate, concentrations at 1 cm and 35 m were estimated using the following formula:

$$\textit{Sea-Nine211}^{\circledR}\ \textit{Concentration at X m} = \left(\frac{\textit{Copper Conc. at Xm}}{\textit{Copper Static Release Rate}}\right) \times \textit{SeaNine}211\,\textit{Release Rate}$$

The concentrations estimated for Sea-Nine211® are presented in Table 2-15.

Table 2-15. Estimated Sea-Nine211® Concentrations

Distance	Concentration with Removal of Background Level (µg/l)
1 cm (End-of-Pipe)	1.0
35 m (Edge of Mixing Zone)	6.5×10^{-3}

Because it is assumed that zinc is also released in a manner analogous to copper from an ablative coating, total zinc concentrations were also calculated using the same approach. Table 2-16 shows the estimated total zinc concentrations.

Table 2-16. Estimated Total Zinc Concentrations

Distance	Concentration with Removal of Background Level (µg/l)
1 cm (End-of-Pipe)	10
35 m (Edge of Mixing Zone)	$6.3x10^{-2}$

Field Information

Field information was not collected as part of the UNDS program from ships coated with advanced antifouling coatings.

Descriptive Information

Descriptive information was not collected as part of the UNDS program for advanced antifouling coatings. As previously stated for copper-containing ablative coatings, hull coating leachate is not discharged from a pipe, but slowly released from the entire underwater hull of a vessel. In addition, constituent concentrations at the 35m edge of the mixing zone are estimated be negligible. Therefore, it is deduced that approved advanced antifouling do not produce a meaningful effect on color, floating materials, odor, settleable materials, taste, or turbidity/colloidal matter in receiving waters.

2.4.1.3 Discharge Generation Rates for Mass Loading

The following hypothetical analysis[1] is performed based on the ten vessels listed in the CVN 68 class. A complete list of Steel, Composite, and Other Non-Aluminum Rigid Hulls vessels is contained in the *Vessel Grouping and Representative Vessel Selection for Hull Coating Leachate Discharge* (EPA and Navy, 2003c). To estimate generation rates, all ten CVN 68 class vessels were considered. The release rate supplied by E Paint Company for Sea-Nine211® and the estimated release rate for zinc were used for all calculations. Table 2-17 presents the estimated generation rates for Sea-Nine211® and Table 2-18 presents the estimated generation rates for zinc for the CVN 68 vessel class assuming all vessels were coated with *E Paint SN-1*. A full listing of vessel classes and characteristics for calculating generation rates and mass loadings is included in Appendix B.

Table 2-17. CVN 68 Vessel Class Estimated Generation Rates for Sea-Nine211®

Class	Number of Vessels	Days In Port	Days in Transit (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (kg Sea-Nine211®/day)			Annual generation rate per class (kg Sea-Nine211®/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
CVN 68	10	147	3	215	$2.7x10^{-1}$	$2.7x10^{-1}$	$2.7x10^{-1}$	$4.0x10^{2}$	8.1	$5.8x10^{2}$

Note: This analysis includes the CVN 76 and CVN 77, neither of which is commissioned. The calculation does not account for a vessel's time in drydock.

[1] The calculations are hypothetical because *E Paint SN-1* is not approved for use on any Navy vessel.

Table 2-18. CVN 68 Vessel Class Estimated Generation Rates for Total Zinc

Class	Number of Vessels	Days In Port	Days in Transit (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (kg Zn/day)			Annual generation rate per class (kg Zn/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
CVN 68	10	147	3	215	2.5	2.5	2.5	$3.7x10^3$	76	$5.4x10^3$

Note: This analysis includes the CVN 76 and CVN 77, neither of which is commissioned. The calculation does not account for a vessel's time in drydock.

2.4.2 Uncertainty Information

While the E Paint Company claims that only Sea-Nine211® is released from *E Paint SN-1*, no data exist to support this claim. A registration letter from EPA provides the release rate for Sea-Nine211® but does not mention zinc. A representative of the company stated that zinc was a pigment encased in the resin and not released to the environment (E Paint, 2003a). EPA does consider zinc oxide to be a biocide in this formulation . The latest product data sheet on *E Paint SN-1* classifies the coating type as a copper and tin-free ablative matrix vehicle (E Paint, 2003b). Panels coated with the product are observed to wear or ablate in Navy tests suggesting the product does have ablative characteristics. There is uncertainty regarding the release rate of zinc from the *E Paint SN-1.* This analysis relies on the assumption that zinc is released at a rate proportional, by weight, to the release rate of Sea-Nine211®.

Seawater concentrations for Sea-Nine211® at varying distances from the hull were estimated assuming the constituents dilutes without degradation. This assumption introduces uncertainty because the Sea-Nine211® is known to have a short half-life in the marine environment. Therefore, this analysis used the conservative assumption that the Sea-Nine211® did not degrade in the marine environment.

Seawater concentrations for zinc at varying distances from the hull were estimated based on the assumption that zinc is released from the coating through the ablative process. Because the company claims that zinc is not released, the use of the ablative analysis introduces uncertainty. However, test panels coated with *E Paint SN-1* showed wear similar to ablative coatings and are the basis for the conservative assumption that the product is ablative (Lawrence, 2003).

3.0 FLEXIBLE HULLS

The Flexible Hulls vessel group includes ships that have their hulls covered with flexible elastomeric materials. The elastomeric material is applied over a steel or composite hull, but is sufficiently thick as to mitigate any consideration of the underlying hull material. Vessels with flexible hulls are typically coated with copper-containing antifouling coatings. This group includes 58 submarines distributed among three classes and the USS CHIEF (MCM 14), a mine countermeasure vessel (Mine, 2002). The Flexible Hulls vessel group includes 1.9% of all Armed Forces vessels that produce the hull coating leachate discharge. The total underwater hull wetted area for this vessel group is 2.2×10^6 ft^2, which is 8.1% of the total underwater hull wetted area for all Armed forces vessels that contribute to this discharge.

The USS LOS ANGELES (SSN 688) class of attack submarines was selected as the representative vessel class for this group. The SSN 688 class has 51 submarines in service, and comprises approximately 86% of the number of vessels in the group. Most of the vessels in this class are submarines and are of similar size and displacement.

This vessel group currently uses the same copper ablative coatings as the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group. Characterization Data of the copper ablative coatings is presented in Section 2.1. The unique operational profile of submarines and their flexible coatings tend to degrade the service life of the currently approved ablative coatings as compared to the service life targets for surface ships (i.e., a maximum of 12 years). Because submarines operate under significantly higher pressure than surface ships and the substrate to which the antifouling coating is applied is flexible, the relatively inflexible ablative coatings tend to crack and spall. The cracking and spalling of the currently approved ablative coatings on submarines limits the life of these coatings to less than 5 years. The Navy has evaluated, and continues to evaluate, more flexible antifouling coatings for use on flexible hulls.

3.1 BASELINE DISCHARGE

As discussed in Section 2.1, the baseline coating for the Flexible Hulls vessel group is defined as a 50/50 use of Ameron ABC #3 and International BRA640. The baseline discharge for this vessels group is the result of constituents leaching from the baseline copper ablative antifouling coating.

3.1.1 Characterization Data

Hull coating leachate discharge from these coatings is comparable to the discharge discussed in the baseline analysis. Studies conducted by the Navy and information supplied by coating manufacturers were used to characterize these coatings and the resulting discharges.

3.1.1.1 Physical Parameters

The SSN 688 class was selected to represent this group of vessels because it contains the largest number of vessels in this class. This class consists of 51 vessels that are 360 feet long with an underwater hull wetted area of 37,700 ft^2 (Navy, 1992). The hull material of these vessels is steel covered with flexible elastomeric materials. SSN 688 class vessels are in U.S. ports for an average of 183 days per year and in transit between 0 nm and 12 nm of U.S. shoreline approximately two days per year (EPA and Navy, 1999). Additional physical parameters are not necessary for the hull coating leachate discharge, because discharge modeling is not conducted to support the environmental effects analyses.

3.1.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical data, field information, and descriptive information for the baseline copper ablative coating are presented in Section 2.1.1.2.

3.1.1.3 Discharge Generation Rates for Mass Loading

To estimate generation rates, all 51 vessels in the SSN 688 class were considered. A complete list of Flexible Hulls vessels is contained in the *Vessel Grouping and Representative Vessel Selection for Hull Coating Leachate Discharge* for (EPA and Navy, 2003c). The static copper release rate for the baseline copper ablative coatings were used for in port estimates, and dynamic release rates were used for underway estimates. Tables 3-1 and 3-2 present the estimated generation rates for total copper and total zinc, respectively, for the SSN 688 vessel class. A full listing of vessel classes and characteristics for calculating generation rates and mass loadings are included in Appendix C.

Table 3-1. SSN 688 Vessel Class Estimated Generation Rates for Total Copper

Class	Number of Vessels	Days In Port	Days in Transit (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (kg Cu/day)			Annual generation rate per class (kg Cu/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
SSN 688	51	183	2	180	3.1×10^{-1}	6.0×10^{-1}	6.0×10^{-1}	2.9×10^{3}	61	5.5×10^{3}

Note: This analysis does not account for a submarine's time in drydock.

Table 3-2. SSN 688 Vessel Class Estimated Generation Rates for Total Zinc

Class	Number of Vessels	Days In Port	Days in Transit (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (kg Zn/day)			Annual generation rate per class (kg Zn/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
SSN 688	51	183	2	180	1.3×10^{-1}	2.4×10^{-1}	2.4×10^{-1}	1.2×10^{3}	24	2.2×10^{3}

Note: This analysis does not account for a submarine's time in drydock.

3.1.2 Uncertainty Information

The uncertainty information for this vessel class and the baseline is the same as for Steel, Composite, and Non-Aluminum Rigid Hulls vessel group except that vinyl antifouling coatings are not used. The discussion of the uncertainty information is contained in Section 2.1.2.

3.2 ESTABLISH A MAXIMUM ALLOWABLE COPPER RELEASE RATE FOR ANTIFOULING COATINGS

This MPCD option group is similar to the baseline discharge. Additional characterization and calculations are not necessary. The same coatings discussed in the baseline discharge would be used to establish the release rate standard. As discussed previously, the numerical maximum allowable copper release rate standard would be based on the results of ongoing Navy testing using the American Society for Testing and Materials (ASTM) D 6442, *Standard Test Method for Copper Release Rates of Antifouling Coating Systems in Seawater* and these results are not expected, or intended, to correlate with actual, in-service leach rates.

3.3 FOUL-RELEASE COATINGS

As discussed in the *Hull Coating Leachate FIAR*, foul-release coatings were tested on an Australian submarine in the 1990s resulting in excessive hull fouling (DSTO, 1995; Holmdahl, 2000). Before foul-release coatings could be applied to U.S. Navy submarines, performance validation testing would be required on an existing Navy nuclear submarine to ensure that significant damage would not occur to critical shipboard systems. Validation testing has not been done. Therefore, the foul-release coatings MPCD option is not feasible for this vessel group, and no characterization was conducted.

3.4 ADVANCED ANTIFOULING COATINGS

The use of advanced antifouling coatings on flexible hulls is not approved by the current specifications for underwater hull antifouling coatings. In Navy testing, panels coated with *E Paint SN-1* did not meet the minimum performance requirements of military specification MIL-PRF-24647 and as such is not authorized for use on Navy vessels (Lawrence, 2003). As a result, this MPCD option is not feasible for the Flexible Hulls vessel group and no characterization was conducted.

4.0 ALUMINUM HULLS

The Aluminum Hulls vessel group includes numerous classes of smaller vessels used by the Armed Forces. Vessels with aluminum hulls include boats and craft ranging from less than 20 feet long to 192 feet long. This vessel group includes approximately 403 vessels, which comprises 13% of all Armed Forces vessels that produce the hull coating leachate discharge. The total underwater hull wetted area for this vessel group is 1.3×10^5 ft^2, which is 0.46% of the total underwater hull wetted area for all Armed forces vessels that contribute to this discharge.

The 47-ft Motor Lifeboat (MLB 47) class was selected as the representative vessel class for this vessel grouping because it contains 71 vessels, which is over a quarter of the total number of vessels in the Aluminum Hulls vessel group. In addition, the MLB 47 class was selected because this is one of the larger classes of Armed Forces vessels with an aluminum hull.

Vessels in the Aluminum Hulls vessel group primarily use foul-release and advanced antifouling coatings that do not contain copper to avoid deposition corrosion that could occur if copper-containing coatings are applied to an aluminum hull. As such, analyses based on copper-containing coatings are not conducted for the aluminum vessel class.

4.1 BASELINE DISCHARGE

Vessels in this vessel group use both foul-release coating and advanced antifouling coatings. Approximately 10% of the vessels in this group currently use foul-release coatings, while the remaining 90% currently use advanced antifouling coatings (Dust, 2003). To facilitate calculations and analyses, the baseline discharge from this vessel group is estimated to result from 10% of the aluminum underwater hull wetted area being coated with International Intersleek 425 and 90% of the area being coated with E Paint Company *E Paint SN-1*.

4.1.1 Characterization Data

Studies conducted by the Navy and information supplied by coating manufacturers were used to characterize these coatings and the resulting discharges.

4.1.1.1 Physical Parameters

The MLB 47 class was selected to represent this group of vessels because it contains over a quarter of the number of vessels and is one of the largest vessels in the Aluminum Hulls vessel group. Each vessel is 47 feet long and has an underwater hull wetted area of 440 ft^2. MLB 47 class vessels are in U.S. ports for an average of 305 days per year and in operation within 12 nm of U.S. shoreline approximately 30 days per year. It is estimated that these vessels are out of the water an average of 30 days per year.

Additional physical parameters are not necessary for the hull coating leachate discharge, because discharge modeling is not conducted to support the environmental effects analysis.

4.1.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

Composition of Coatings

The constituents for International Intersleek 425 and *E Paint SN-1* are presented in Tables 4-1 and 4-2, respectively.

Table 4-1. Constituents for International Intersleek 425

Constituent[a]	Approximate Coating Weight % from MSDS[a]
Ethyl benzene	11
Titanium dioxide	11
Xylenes (o-, m-, and p- isomers)	11

[a]Source: International Intersleek 425 MSDS (International, 2002c).
- The MSDS reported a weight percentage range. The constituent weight percentage presented is the maximum value.
- The MSDS did not report information regarding the balance of constituents. The remaining percentage of coating constituents may include silicon, resins, oils, pigments, and fillers.

Table 4-2. Constituents for E Paint Company *E Paint SN-1*

Constituent[a]	Approximate Coating Weight % from MSDS[a]
Zinc oxide	36
Ethyl benzene	21
Sea-Nine211® (4,5-dichloro-2-n-octyl-4-isothiazolin-3-one)	3.0
Xylene	1.9
Toluene	1.2

[a]Source: E Paint Company MSDS for *E Paint SN-1* (E Paint, 2002).
- The MSDS did not report information regarding the balance of constituents. The remaining percentage of coating constituents may include silicon, resins, oils, pigments, and fillers.

Constituent Release Rates

Foul-release coatings do not release any biocides as discussed in Section 2.3.1.2. The release rates of any other constituents in foul-release coatings are estimated to be negligible.

E Paint Company supplied the release rate for Sea-Nine211® (EPA, 2001), and the remaining coating constituent release rates were estimated from analysis discussed in Section 2.4.1.2. Table 4-3 presents the release rates for the constituents in *E Paint SN-1*.

Table 4-3. Release Rates for E Paint Company *E Paint SN-1*

Constituent	Release Rate [µg/cm²)/day]
Sea-Nine211® (4,5-dichloro-2-n-octyl-4-isothiazolin-3-one)	1.8 [b]
Zinc oxide	17
Ethyl benzene[a]	0.0
Xylene[a]	0.0
Toluene[a]	0.0

[a]-VOCs are estimated to not be present in the cured coating.
[b]- Average leaching rate measured by ASTM Standard Test Method D 5108-90.

As presented in Section 2.4.1.2, the biocide Sea-Nine211® has a short half-life (i.e., less than one hour) in the marine environment (Rohm and Haas, 2003). Due to this short half-life, no studies were available to estimate concentrations in the water of Sea-Nine211® at varying distances from the hull. Concentrations for Sea-Nine211® were estimated assuming the constituents dilutes without degradation. This assumption may result in an over-estimate of concentrations because Sea-Nine211® has a short half-life.

Using the copper information presented in Section 2.1.1.2 and the known Sea-Nine211® release rate, concentrations at 1 cm and 35m were estimated using the following formula:

$$\textit{Sea-Nine211}^{®}\ \textit{Concentration at X m} = \left(\frac{\textit{Copper Conc. at Xm}}{\textit{Copper Static Release Rate}} \right) \times \textit{SeaNine211 Release Rate}$$

The 35 m value was estimated with the removal of background concentration levels. The concentrations estimated for Sea-Nine211® are presented in Table 4-4.

Table 4-4. Estimated Sea-Nine211® Concentrations

Distance	Concentration with Removal of Background Level (µg/l)
1 cm (End-of-Pipe)	1.0
35 m (Edge of Mixing Zone)	6.5×10^{-3}

Because it is assumed that zinc is released through the ablative process, total zinc concentrations were also calculated using the same approach. The concentrations estimated for total zinc are presented in Table 4-5.

Table 4-5. Estimated Total Zinc Concentrations

Distance	Concentration with Removal of Background Level (µg/l)
1 cm (End-of-Pipe)	10
35 m (Edge of Mixing Zone)	6.3×10^{-2}

Field Information

Field information was not collected as part of the UNDS program for foul-release or advanced antifouling coatings.

Descriptive Information

Descriptive information is not available for foul-release or advanced antifouling coatings. As previously stated, hull coating leachate is not discharge from a pipe but slowly released from the entire underwater hull of a vessel. The release of foul-release coating constituents is estimated to be negligible. In addition, advanced antifouling coating constituent concentrations at the 35m edge of the mixing zone are also negligible. Therefore, it is deduced that these coatings do not produce an effect on color, floating materials, odor, settleable materials, taste, or turbidity/colloidal matter in receiving waters.

4.1.1.3 Discharge Generation Rates for Mass Loadings

The release rates of constituents from International Intersleek 425 are estimated to be negligible. Therefore, generation rates for foul-release coatings are assumed to be zero.

As discussed in Section 2.4, *E Paint SN-1* releases a biocide called Sea-Nine211®. Tables 4-6 and 4-7 present the estimated baseline discharge generation rate for Sea-Nine211® and total zinc based on a 90% usage (i.e., 64 vessels coated with *E Paint SN-1* produce discharge of Sea-Nine211® and total zinc) for the MLB 47 vessel class. A full listing of vessel classes and characteristics for calculating generation rates and mass loadings are included in Appendix D.

Table 4-6. MLB 47 Vessel Class Estimated Generation Rates for Sea-Nine211® for the Baseline Discharge

Class	Number of Vessels	Days In Port	Days Operating w/in 12 nm	Days Underway (12+ nm)	Daily generation rate per vessel (kg Sea-Nine 211/day)			Annual generation rate per class (kg Sea-Nine 211/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
MLB 47	64	305	30	0	7.4×10^{-4}	7.4×10^{-4}	0	14	1.4	0

Note: This analysis does not account for a vessel's time in drydock.

Table 4-7. MLB 47 Vessel Class Estimated Generation Rates for Total Zinc for the Baseline Discharge

Class	Number of Vessels	Days In Port	Days Operating w/in 12 nm	Days Underway (12+ nm)	Daily generation rate per vessel (kg Zn/day)			Annual generation rate per class (kg Zn/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
MLB 47	64	305	30	0	$7.0x10^{-3}$	$7.0x10^{-3}$	0	$1.4x10^{2}$	13	0

Note: This analysis does not account for a vessel's time in drydock.

4.1.2 Uncertainty Information

It is estimated that 90% of aluminum-hulled vessels use advanced antifouling coatings, while the other 10% use foul-release coatings. The high use of advanced antifouling coatings is indicative of USCG findings that foul-release coatings are too vulnerable to damage to be cost effective as compared with the advanced antifouling coatings. As a result, there is uncertainty associated with the number of vessels coated with foul-release and with advanced antifouling coatings.

Foul-release coatings are not designed to release constituents and do not contain biocides. No studies have been conducted identifying or quantifying constituents released from foul-release coatings.

While the E Paint Company claims that only Sea-Nine211® is released from *E Paint SN-1*, no data exist to support this claim. A registration letter from EPA provides the release rate for Sea-Nine211® but does not mention zinc. A representative of the company stated that zinc was a pigment encased in the resin and not released to the environment (E Paint, 2003a). EPA does consider zinc oxide to be a biocide in this formulation (citation needed from EPA). The latest product data sheet on *E Paint SN-1* classifies the coating type as a copper and tin-free ablative matrix vehicle (E Paint, 2003b). Panels coated with the product are observed to wear or ablate in Navy tests suggesting the product does have ablative characteristics. There is uncertainty regarding the release rate of zinc from the *E Paint SN-1*. This analysis relies on the assumption that zinc is released at a rate proportional, by weight, to the release rate of Sea-Nine211®.

Seawater concentrations for Sea-Nine211® at varying distances from the hull were estimated assuming the constituents dilutes without degradation. This assumption introduces uncertainty because the Sea-Nine211® is known to have a short half-life in the marine environment. Therefore, this analysis used the conservative assumption that the Sea-Nine211® did not degrade in the marine environment.

Seawater concentrations for zinc at varying distances from the hull were estimated based on the assumption that zinc is released from the coating through the ablative process. Because the company claims that zinc is not released, the use of the ablative analysis introduces uncertainty. However, test panels coated with *E Paint SN-1* showed wear similar to ablative coatings and are the basis for the conservative assumption that the product is ablative (Lawrence, 2003).

4.2 ESTABLISH A MAXIMUM ALLOWABLE COPPER RELEASE RATE FOR ANTIFOULING COATINGS

No Armed Forces coating policy allows use of copper ablative coatings on aluminum vessels and the use of the copper ablative coatings on aluminum hulls is not recommended by vessel manufacturers (Navy, 2001a; USCG, 2001). Copper ablative coatings are not allowed on aluminum hulls because copper from the coating can deposit on the aluminum hull at scratches or defects and cause accelerated hull corrosion (Jones, 1992; Lamtec, 2001). Based on these broad prohibitions, the MPCD option to “Establish a Maximum Allowable Copper Release Rate for Antifouling Coatings” is not feasible for this vessel group; and therefore, no characterization was conducted (EPA and Navy, 2003d).

4.3 FOUL-RELEASE COATINGS

This option group does not vary among vessel groups. As stated in Section 2.3.1.2, International Intersleek 425 does not use biocides to control fouling, and the release of constituents is estimated to be negligible. Additional characterization is not necessary for this MPCD option group in this vessel group, because the physical parameters of the vessel group do not change from the baseline discharge, which is presented in Section 4.1.1.1.

4.4 ADVANCED ANTIFOULING COATINGS

The advanced antifouling coatings MPCD option group does not vary among vessel groups. The advanced antifouling coating, *E Paint SN-1*, is used as the basis for all analyses.

4.4.1 Characterization Data

Characterization of advanced antifouling coatings and the resulting discharge is presented in the following sections. Information supplied by the E Paint Company is the basis for all assumptions.

4.4.1.1 Physical Parameters

The physical parameters of the vessel group do not change among MPCD option groups. The MLB 47 class physical parameters are presented in Section 4.1.1.1.

4.4.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical data, field information, and descriptive information for the advanced antifouling coatings are presented in Section 2.4.1.2.

4.4.1.3 Discharge Generation Rates for Mass Loading

To estimate generation rates, all 71 vessels of the MLB 47 class were considered. The release rate supplied by E Paint Company for Sea-Nine211® was used for all calculations. Tables 4-8 and 4-9 present the estimated generation rates Sea-Nine211® and total zinc for the MLB 47 vessel class if all of the hulls were coated with *E Paint SN-1*. A full listing of vessel classes and characteristics for calculating generation rates and mass loadings is included in Appendix D.

Table 4-8. MLB 47 Vessel Class Estimated Generation Rates for Sea-Nine211® for the Advanced Antifouling Coatings MPCD Option Group

Class	Number of Vessels	Days In Port	Days Operating w/in 12 nm	Days Underway (12+ nm)	Daily generation rate per vessel (kg Sea-Nine 211/day)			Annual generation rate per class (kg Sea-Nine 211/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
MLB 47	71	305	30	0	7.4×10^{-4}	7.4×10^{-4}	0	16	1.6	0

Note: This analysis does not account for a vessel's time in drydock.

Table 4-9. MLB 47 Vessel Class Estimated Generation Rates for Total Zinc for the Advanced Antifouling Coatings MPCD Option Group

Class	Number of Vessels	Days In Port	Days Operating w/in 12 nm	Days Underway (12+ nm)	Daily generation rate per vessel (kg Zn/day)			Annual generation rate per class (kg Zn/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
MLB 47	71	305	30	0	7.0×10^{-3}	7.0×10^{-3}	0	1.5×10^{2}	15	0

Note: This analysis does not account for a vessel's time in drydock.

4.4.2 Uncertainty Information

The uncertainty information for this vessel group and MPCD option group is the same as the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group and advanced coatings option group. Refer to section 2.4.2 for uncertainty information.

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Appendix A. Additional Coatings Qualified to MIL-PRF-24647

Table A-1. Constituents for Ameron ABC #4 (Red)

Constituent	Weight % in Coating as Listed in MSDS
Cuprous oxide	35.0
Zinc oxide	20.0
Magnesium silicate	10.0
Xylene	9.5
Additive (as butyl acetate)	5.0
vinyl chloride copolymer	5.0
Acrylic resin	5.0
Iron oxide	5.0
Butyl acetate	3.0
Terpineol	2.7
Ethyl benzene	2.3
Cyclohexanone	1.9

Source: MSDS for Ameron ABC #4 (Ameron, 2002b)
-The MSDS reported the weight percentage to be is less than or equal to these values.

Table A-2. Constituents for Hempel Olympic 7660 (Red)

Constituent	Weight % in Coating as Listed in MSDS
Cuprous oxide	45.0
Zinc oxide	10.0
Para-xylene	10.0
Gum rosin (colophony)	10.0
Meta-xylene	2.5
Ethyl benzene	2.5
Butanol	2.5
Iron oxide	2.5

Source: MSDS for Hempel Olympic 7660 (Red) (Hempel, 2002)
- The MSDS reported a weight percentage range. The constituent weight percentage presented here is the midpoint of the range. Using the maximum value would result in the total exceeding 100%.

Appendix B. Operational Characteristics for the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

Table B-1. Fresh Water Service Vessels in the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Area (ft^2)	Days in Port	Days Underway
AIR FORCE	TR 21	1	21	88	150	65
AIR FORCE	U 22	2	22	97	150	65
NAVY	AR 63	1	63	792	300	40
NAVY	BW 25	1	25	124	155	60
NAVY	HS 24	1	24	115	55	300
NAVY	IX 310	1	192	11698	325	30
NAVY	IX 531	1	102	4110	205	150
NAVY	LCM 6 (N)	2	56	990	305	60
NAVY	LCM 8 (N)	6	74	1603	295	60
NAVY	LCPL 36	5	36	258	305	60
NAVY	LCU 1610	1	135	3915	265	40
NAVY	ML 35	1	35	243	205	60
NAVY	MW 26	4	26	134	205	60
NAVY	NS 20	1	20	80	305	60
NAVY	NS 25	2	25	124	305	60
NAVY	NS 28	1	28	156	305	60
NAVY	NS 32	1	32	203	305	60
NAVY	NS 35	1	35	243	305	60
NAVY	NS 36	1	36	258	305	60
NAVY	NS 39	1	39	302	305	60
NAVY	PE 26	2	26	134	305	60
NAVY	PE 33	1	33	216	305	60
NAVY	PE 40	1	40	318	305	60
NAVY	UB 21	1	21	88	195	150
NAVY	UB 22	5	22	97	195	150
NAVY	UB 40	1	40	318	195	150
NAVY	WB 24	1	24	115	195	150
NAVY	WB 50	3	50	498	195	150
NAVY	WB 74	1	74	1603	195	150
NAVY	YC 1273	1	100	5680	295	60
NAVY	YC 1366	1	110	6170	295	60
NAVY	YC 981	1	142	8228	295	60
NAVY	YCF 14	1	150	6572	305	60
NAVY	YFNX 22	1	110	7214	295	60
USCG	ANB 63	1	63	792	235	110
USCG	ANB 64	2	64	817	235	110
USCG	BARGE 120	2	120	7700	146	205
USCG	BARGE 130	6	130	5500	146	205
USCG	BARGE 90	2	90	2844	146	205
USCG	BARGE 99	2	99	4002	146	205
USCG	BUSL 49	6	49	478	146	205
USCG	MLB 44	6	44	385	305	30

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Area (ft^2)	Days in Port	Days Underway
USCG	PWB 21	5	21	88	155	200
USCG	SKI 14	7	14	40	15	100
USCG	TPSB 25	4	25	124	245	100
USCG	UTL 18	1	18	65	195	150
USCG	UTL 20	1	20	80	195	150
USCG	UTL 21	2	21	88	195	150
USCG	UTL 22	1	22	97	195	150
USCG	UTL 23	4	23	105	195	150
USCG	UTL 24	1	24	115	195	150
USCG	UTL 25	1	25	124	195	150
USCG	UTM 27	1	27	145	195	150
USCG	UTM 30	2	30	179	195	150
USCG	WLB 180	2	180	6751	135	100
USCG	WLB 225	2	225	10357	135	100
USCG	WLI 100	1	100	2432	146	205
USCG	WLIC 100	1	100	2432	146	205
USCG	WLIC 75	1	75	1753	146	205
USCG	WLM 175	1	175	6408	123	200
USCG	WLR 65	3	65	1575	140	205
USCG	WLR 75	6	75	1621	140	205

Table B-2. Salt Water Service Vessels in the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
AIR FORCE	U 22	3	22	97	150	65
AIR FORCE	U 24	1	24	115	290	65
AIR FORCE	U 25	1	25	124	290	65
AIR FORCE	U 31	1	31	191	290	65
ARMY	BC	3	110	4088	335	0
ARMY	BC-7005	2	110	4088	335	0
ARMY	BD 115T	6	200	10442	335	0
ARMY	BG	4	120	6714	335	0
ARMY	BK	4	45	1947	335	0
ARMY	J BOAT 27	8	27	145	290	65
ARMY	J BOAT 46	1	46	421	285	50
ARMY	LCM 8 (A)	38	74	1603	295	60
ARMY	LCU 1610	1	135	3915	265	40
ARMY	LCU 2000	29	174	6646	265	30
ARMY	LSV	9	273	17470	120	30
ARMY	LT 100	1	107	6105	275	60
ARMY	LT 128	5	128	9856	215	60

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
ARMY	Q-BOAT	1	65	843	275	60
ARMY	ST 900	12	59	1252	285	60
MSC	AOE 6	1	730	94141	186	4
MSC	LCM 8 (N)	30	74	1603	295	60
MSC	MW 26	3	26	134	205	60
MSC	T-AE 26	7	564	54240	245	20
MSC	T-AFS 1	3	581	46930	245	20
MSC	T-AFS 8	3	524	45779	245	20
MSC	T-AG 195	1	247	59126	145	20
MSC	T-AGM 23	1	564	47791	275	40
MSC	T-AGOS 1	6	224	9445	145	20
MSC	T-AGOS 19	4	232	13340	145	20
MSC	T-AGOS 23	1	282	19691	145	20
MSC	T-AGS 45	1	442	36590	245	20
MSC	T-AGS 51	2	208	10085	245	20
MSC	T-AGS 60	6	329	19383	245	20
MSC	T-AH 19	2	894	123862	315	20
MSC	T-AKR 287	8	947	111650	295	20
MSC	T-AKR 295	4	907	107028	295	20
MSC	T-AKR 300	7	950	118594	295	20
MSC	T-AKR 310	8	950	119396	295	20
MSC	T-AO 187	13	677	44511	295	20
MSC	T-ARC 7	1	503	41176	245	20
MSC	T-ATF 166	6	226	11398	245	20
MSC	UB 40	1	40	318	195	150
NAVY	AC 1	2	50	498	285	60
NAVY	AE 26	1	540	54240	245	20
NAVY	AFDL 1	1	200	28112	305	60
NAVY	AFDM 3	2	622	47645	305	60
NAVY	AGF 11	1	548	46594	183	4
NAVY	AGOR 14	2	220	10173	145	20
NAVY	AGOR 23	3	243	13960	145	20
NAVY	AGOR 26	1	172	10869	145	20
NAVY	AGSS 555	1	152	9130	305	60
NAVY	AOE 1	4	770	95754	114	2
NAVY	AOE 6	3	730	94141	186	4
NAVY	AP 27	4	27	145	105	60
NAVY	APL 17	3	261	18369	355	0
NAVY	APL 2	4	261	18369	355	0
NAVY	APL 41	2	261	18369	355	0
NAVY	APL 53	1	261	18369	355	0
NAVY	APL 61	2	360	37800	355	0
NAVY	APL 65	2	260	20960	355	0
NAVY	AR 40	1	40	318	300	10
NAVY	AR 63	1	63	792	300	10
NAVY	ARDM 4	2	492	47645	305	60
NAVY	ARS 50	4	240	13299	156	60
NAVY	AS 39	2	620	58336	235	60
NAVY	ASDV	3	135	2657	295	60
NAVY	BW 22	1	22	97	155	60

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
NAVY	BW 25	1	25	124	155	60
NAVY	CC 38	1	38	287	255	60
NAVY	CG 47	24	529	40434	166	4
NAVY	CT 60	1	60	718	285	60
NAVY	CV 63	1	990	141470	147	3
NAVY	CV 67	1	990	145350	147	3
NAVY	CVN 65	1	1040	156990	147	3
NAVY	CVN 68	10	1040	159500	147	3
NAVY	DD 963	18	529	38661	178	4
NAVY	DDG 51	51	446	33443	109	63
NAVY	DS 22	2	22	97	295	60
NAVY	DW 50	8	50	498	305	60
NAVY	FFG 7	33	408	22902	168	4
NAVY	FR 22	1	22	97	225	40
NAVY	HH 30	1	30	179	285	60
NAVY	HL 29	1	29	167	225	60
NAVY	HL 34	3	34	230	225	60
NAVY	HL 36	1	36	258	225	60
NAVY	HS 24	21	24	115	55	300
NAVY	HSAC	1	40	350	196	52
NAVY	IX 502	1	316	26048	355	0
NAVY	IX 508	1	135	3557	315	30
NAVY	IX 514	1	125	7076	265	60
NAVY	IX 516	1	303	44562	315	30
NAVY	IX 517	1	196	8394	335	30
NAVY	IX 520	1	260	19538	355	0
NAVY	IX 521	1	280	28880	305	60
NAVY	IX 522	1	256	26528	305	60
NAVY	IX 523	1	168	10576	245	100
NAVY	IX 524	1	256	23840	305	60
NAVY	IX 525	1	927	258606	305	60
NAVY	IX 527	1	110	5792	335	0
NAVY	IX 528	1	150	7308	305	60
NAVY	IX 529	1	118	12124	335	30
NAVY	IX 530	1	110	5756	305	60
NAVY	LCC 19	1	580	51250	172	10
NAVY	LCM 6 (N)	14	56	990	305	60
NAVY	LCM 8 (N)	40	74	1603	295	60
NAVY	LCPL 11	10	36	258	305	60
NAVY	LCPL 36	76	36	258	305	60
NAVY	LCU 1466	1	119	4415	275	40
NAVY	LCU 1610	35	135	3915	265	40
NAVY	LHA 1	4	778	87465	166	10
NAVY	LHD 1	7	778	88449	180	10
NAVY	LHD 8	1	844	88965	180	10
NAVY	LPD 1	3	500	41026	172	10
NAVY	LPD 14	2	548	46888	172	10
NAVY	LPD 17	12	684	64788	172	10
NAVY	LPD 7	5	548	48059	172	10
NAVY	LSD 36	3	540	43406	216	4

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
NAVY	LSD 41	6	580	48350	170	5
NAVY	LSD 49	4	580	48772	190	54
NAVY	LST 1179	1	500	34650	178	4
NAVY	MC 27	1	27	145	205	60
NAVY	MC 40	1	40	318	205	60
NAVY	MCM 1	8	217	8410	233	9
NAVY	MCS 12	1	556	49945	86	3
NAVY	MHC 51	12	174	6418	242	123
NAVY	ML 40	1	40	318	205	60
NAVY	MM 25	3	25	124	85	60
NAVY	MW 26	14	26	134	205	60
NAVY	NR 1	1	137	5595	315	40
NAVY	NS 111	1	125	2813	285	60
NAVY	NS 143	1	143	4598	305	60
NAVY	NS 180	2	180	7502	305	60
NAVY	NS 20	1	20	80	305	60
NAVY	NS 21	2	21	88	305	60
NAVY	NS 22	8	22	97	305	60
NAVY	NS 23	1	23	105	305	60
NAVY	NS 24	1	24	115	305	60
NAVY	NS 25	2	25	124	305	60
NAVY	NS 26	2	26	134	305	60
NAVY	NS 27	2	27	145	305	60
NAVY	NS 28	3	28	156	305	60
NAVY	NS 30	1	30	179	5	60
NAVY	NS 32	2	32	203	305	60
NAVY	NS 33	1	33	216	305	60
NAVY	NS 35	1	35	243	305	60
NAVY	NS 36	1	36	258	305	60
NAVY	NS 38	1	38	287	305	60
NAVY	NS 39	1	39	302	305	60
NAVY	NS 40	4	40	318	305	60
NAVY	NS 41	2	41	334	305	60
NAVY	NS 49	1	49	478	5	60
NAVY	NS 53	1	53	560	305	60
NAVY	NS 54	2	54	581	305	60
NAVY	NS 55	1	55	603	305	60
NAVY	NS 57	1	57	648	305	60
NAVY	NS 95	1	95	1477	295	60
NAVY	PC 1	13	170	3704	95	6
NAVY	PE 10	2	33	216	305	60
NAVY	PE 12	3	39	302	305	60
NAVY	PE 22	2	22	97	215	100
NAVY	PE 24	1	24	115	215	100
NAVY	PE 26	12	26	134	305	60
NAVY	PE 33	11	33	216	305	60
NAVY	PE 40	18	40	318	305	60
NAVY	PE 8	14	26	134	305	60
NAVY	PR 40	3	40	318	305	60
NAVY	QST 35	27	56	625	196	52

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
NAVY	SC 22	3	22	97	255	60
NAVY	SC 27	3	27	145	305	60
NAVY	SC 65	5	65	843	285	60
NAVY	SSBN 726	18	560	69600	183	2
NAVY	ST 44	20	44	385	65	100
NAVY	TC 27	1	27	145	305	60
NAVY	TC 28	1	28	156	305	60
NAVY	TC 42	1	42	351	215	100
NAVY	TC 43	1	43	368	215	100
NAVY	TC 49	1	49	478	215	100
NAVY	TR 100	3	100	1954	305	5
NAVY	TR 120	6	120	2127	305	5
NAVY	TR 72	3	72	1035	295	5
NAVY	UB 10	3	33	216	300	65
NAVY	UB 12	2	39	302	195	150
NAVY	UB 15	37	49	478	195	150
NAVY	UB 21	2	21	88	195	150
NAVY	UB 22	81	22	97	195	150
NAVY	UB 25	7	25	124	195	150
NAVY	UB 27	6	27	145	195	150
NAVY	UB 28	1	28	156	195	150
NAVY	UB 32	1	32	203	195	150
NAVY	UB 33	3	33	216	195	150
NAVY	UB 40	13	40	318	195	150
NAVY	UB 50	24	50	498	195	150
NAVY	WB 110	1	110	2536	195	150
NAVY	WB 135	3	135	2557	275	60
NAVY	WB 15	12	49	478	195	150
NAVY	WB 180	1	180	7534	215	150
NAVY	WB 20	1	20	80	195	150
NAVY	WB 24	28	24	115	195	150
NAVY	WB 25	1	25	124	195	150
NAVY	WB 26	1	26	134	195	150
NAVY	WB 27	1	27	145	195	150
NAVY	WB 28	1	28	156	195	150
NAVY	WB 30	2	30	179	195	150
NAVY	WB 31	1	31	191	195	150
NAVY	WB 34	1	34	230	195	150
NAVY	WB 35	10	35	243	195	150
NAVY	WB 41	2	41	334	195	150
NAVY	WB 45	5	45	403	195	150
NAVY	WB 50	74	50	498	195	150
NAVY	WB 56	1	56	625	195	150
NAVY	WB 74	12	74	1603	195	150
NAVY	WH 12	1	12	30	55	60
NAVY	WH 16	6	16	52	55	60
NAVY	YC 1026	2	150	8660	295	60
NAVY	YC 1321	2	125	6158	295	60
NAVY	YC 1351	1	81	3051	295	60
NAVY	YC 1366	5	110	6170	295	60

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
NAVY	YC 1389	1	160	11536	295	60
NAVY	YC 1427	3	110	6044	295	60
NAVY	YC 1436	1	120	6408	295	60
NAVY	YC 1448	2	130	5820	295	60
NAVY	YC 1461	2	110	5792	295	60
NAVY	YC 1469	22	110	5792	295	60
NAVY	YC 1500	4	110	6170	295	60
NAVY	YC 1517	36	110	5792	295	60
NAVY	YC 1607	39	110	5224	295	60
NAVY	YC 161	1	110	5540	295	60
NAVY	YC 255	16	110	6170	295	60
NAVY	YC 688	7	110	4538	295	60
NAVY	YC 981	1	142	8228	295	60
NAVY	YCV 7	3	200	17240	305	60
NAVY	YD 113	5	140	15260	325	30
NAVY	YD 120	2	140	15318	325	30
NAVY	YD 150	1	198	14876	325	30
NAVY	YD 159	1	120	9360	325	30
NAVY	YD 210	3	142	10636	325	30
NAVY	YD 222	1	142	9986	325	30
NAVY	YD 223	4	140	12740	325	30
NAVY	YD 232	3	142	10636	325	30
NAVY	YD 243	1	140	11036	325	30
NAVY	YD 246	9	175	16125	325	30
NAVY	YD 247	5	175	15125	325	30
NAVY	YFN 1154	3	110	6170	295	60
NAVY	YFN 1172	3	110	4420	295	60
NAVY	YFN 1173	5	110	5756	295	60
NAVY	YFN 1196	8	110	5792	295	60
NAVY	YFN 1239	2	110	5792	295	60
NAVY	YFN 1254	14	110	6170	335	0
NAVY	YFN 1277	7	110	6170	295	60
NAVY	YFN 161	31	110	6170	295	60
NAVY	YFNB 2	6	260	18024	295	60
NAVY	YFNB 47	1	152	7728	295	60
NAVY	YFND 5	3	110	5880	305	60
NAVY	YFNX 15	1	110	5468	295	60
NAVY	YFNX 20	1	110	4538	295	60
NAVY	YFNX 24	1	110	5792	295	60
NAVY	YFNX 30	1	110	5180	295	60
NAVY	YFNX 31	1	110	5346	295	60
NAVY	YFNX 35	1	153	8025	295	60
NAVY	YFNX 36	1	110	5918	295	60
NAVY	YFNX 39	1	110	5918	295	60
NAVY	YFNX 40	1	110	5792	295	60
NAVY	YFNX 42	1	110	6170	295	60
NAVY	YFNX 43	1	110	6076	295	60
NAVY	YFNX 44	1	127	6713	295	60
NAVY	YFU 71	1	125	7076	155	200
NAVY	YFU 91	1	115	5525	155	200

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
NAVY	YGN 80	3	124	7520	305	60
NAVY	YL 30	1	30	179	65	100
NAVY	YLC 1	1	110	5224	325	30
NAVY	YLC 2	1	110	4088	325	30
NAVY	YMN 1	1	154	6330	305	60
NAVY	YNG 1	2	110	4892	305	60
NAVY	YOGN 106	5	165	10242	205	150
NAVY	YOGN 123	1	230	14012	205	150
NAVY	YOGN 8	2	165	8975	205	150
NAVY	YON 245	18	165	9880	205	150
NAVY	YON 307	11	184	10820	205	150
NAVY	YON 89	3	165	8975	205	150
NAVY	YOS 14	1	110	6332	200	145
NAVY	YOS 33	3	165	8975	200	145
NAVY	YOS 4	1	110	6332	200	145
NAVY	YP 654	2	81	1051	195	150
NAVY	YP 676	21	108	2221	205	150
NAVY	YPD 45	1	110	6044	330	30
NAVY	YR 24	4	150	7632	330	39
NAVY	YR 26	5	153	7776	280	30
NAVY	YR 83	1	111	4176	330	30
NAVY	YR 84	2	210	7350	330	30
NAVY	YR 92	1	110	4320	330	30
NAVY	YR 93	1	261	18090	330	30
NAVY	YR 94	1	261	18090	330	30
NAVY	YRB 25	1	110	4892	325	30
NAVY	YRB 29	1	124	7688	325	30
NAVY	YRB 30	2	261	18090	325	30
NAVY	YRB 31	2	150	7632	325	30
NAVY	YRB 32	2	153	7632	325	30
NAVY	YRB 33	2	150	7632	325	30
NAVY	YRBM 1	1	110	4604	325	30
NAVY	YRBM 20	1	261	18090	325	30
NAVY	YRBM 23	8	146	8252	325	30
NAVY	YRBM 31	16	146	8252	325	30
NAVY	YRBM 48	2	150	7632	325	30
NAVY	YRBM 49	2	150	7632	325	30
NAVY	YRBM 5	5	112	5216	325	30
NAVY	YRBM 50	2	150	9152	325	30
NAVY	YRBM 51	2	153	7776	325	30
NAVY	YRBM 52	2	150	7632	325	30
NAVY	YRBM 53	2	150	7632	325	30
NAVY	YRDH 1	1	153	7611	305	60
NAVY	YRDM 1	1	153	7611	330	30
NAVY	YRR 11	3	151	7517	325	30
NAVY	YRR 2	1	153	7776	325	30
NAVY	YRR 5	1	150	7632	325	30
NAVY	YSD 11	1	104	4304	295	60
NAVY	YSR 30	2	110	6460	255	100
NAVY	YTB 760	19	109	3265	285	60

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
NAVY	YTL 422	1	66	1015	295	60
NAVY	YTT 9	2	186	12412	305	60
NAVY	YWN 60	1	165	8975	305	60
USCG	ANB 64	1	64	817	235	100
USCG	BARGE 60	1	60	1680	146	205
USCG	BARGE 68	6	68	2368	146	205
USCG	BARGE 70	1	70	2300	146	205
USCG	BARGE 84	2	84	3248	146	205
USCG	BU 45	4	45	403	205	150
USCG	BUSL 49	22	49	478	146	205
USCG	MCB 25	1	26	134	135	200
USCG	MLB 44	23	44	385	305	30
USCG	MSB 26	21	26	134	305	30
USCG	PWB 19	1	19	72	155	200
USCG	PWB 21	2	21	88	155	200
USCG	PWB 22	1	22	97	155	200
USCG	PWB 23	1	23	105	155	200
USCG	PWB 27	3	27	145	155	200
USCG	PWB 32	1	33	216	155	200
USCG	SB 10	2	10	10	65	100
USCG	SB 12	27	12	30	65	100
USCG	SB 14	19	14	40	65	100
USCG	SB 15	1	15	46	65	100
USCG	SB 16	28	16	52	65	100
USCG	SB 18	8	18	65	65	100
USCG	SB 22	17	22	97	65	100
USCG	SB 30	3	30	179	65	100
USCG	SB 40	1	40	318	65	100
USCG	SB 41	1	41	334	65	100
USCG	SB 44	8	44	385	65	100
USCG	SRB 30	2	30	179	255	100
USCG	TPSB 25	16	25	124	245	100
USCG	UTL 17	1	17	58	195	150
USCG	UTL 18	3	18	65	195	150
USCG	UTL 19	1	19	72	195	150
USCG	UTL 21	6	21	88	195	150
USCG	UTL 22	5	22	97	195	150
USCG	UTL 23	11	23	105	195	150
USCG	UTL 24	4	24	115	195	150
USCG	UTL 25	4	25	124	195	150
USCG	UTL 26	1	26	134	195	150
USCG	UTL 27	5	27	145	195	150
USCG	UTL 28	1	28	156	195	150
USCG	UTM 27	3	27	145	195	150
USCG	WHEC 378	12	379	17339	116	26
USCG	WIX 180	1	180	6751	135	100
USCG	WIX 295	1	295	12264	196	36
USCG	WLB 180	3	180	6751	135	100
USCG	WLB 225	14	225	10357	135	100
USCG	WLI 65 303	1	65	1037	146	205

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
USCG	WLI 65 400	2	65	1142	146	205
USCG	WLIC 100	1	100	2432	146	205
USCG	WLIC 160	4	160	5113	146	205
USCG	WLIC 75	8	75	1753	146	205
USCG	WLM 133	1	133	4648	149	150
USCG	WLM 175	13	175	6408	123	200
USCG	WMEC 210	16	210	6950	176	12
USCG	WMEC 213	1	213	8337	176	12
USCG	WMEC 230	1	230	8621	176	12
USCG	WMEC 270	13	270	10976	176	12
USCG	WMEC 282	1	282	14191	176	12
USCG	WPB 110	49	110	2171	127	200
USCG	WPB 82	2	83	1243	297	30
USCG	WPB 87	50	87	1514	114	200
USCG	WYTL 65	12	65	1083	38	300

Appendix C. Operational Characteristics for the Flexible Hulls vessel group

Table C-1. Salt Water Service Vessels in the Flexible Hulls vessel group

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
NAVY	MCM 1	1	217	8410	233	9
NAVY	SSN 21	3	353	46400	183	2
NAVY	SSN 688	51	360	37700	183	2
NAVY	SSN 774	4	377	38300	183	2

Note: Flexible hull vessels do not operate in fresh water.

Appendix D. Operational Characteristics for the Aluminum Hulls Vessel Group

Table D-1. Fresh Water Service Vessels in the Aluminum Hulls Vessel Group

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway within 12 nm
USCG	ANB(X) 34	1	34	230	235	100
USCG	MLB 47	14	47	440	305	30
USCG	TANB 21 CI	4	21	88	245	100
USCG	TANB 21 SI IB	3	21	88	245	100
USCG	UTB 41	20	41	334	95	263
USCG	UTL 17	4	17	58	195	150
USCG	UTL 18	1	18	65	195	150
USCG	UTL 20	1	20	80	195	150
USCG	UTL 21	2	21	88	195	150
USCG	UTL 22	1	22	97	195	150
USCG	UTL 23	5	23	105	195	150
USCG	UTL 24	1	24	115	195	150
USCG	UTL 25	1	25	124	195	150
USCG	UTM 27	1	27	145	195	150
USCG	UTM 28	1	28	156	195	150
USCG	UTM 30	2	30	179	195	150

Table D-2. Salt Water Service Vessels in the Aluminum Hulls Vessel Group

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
ARMY	FB	1	65	843	275	30
NAVY	BH 22	1	22	97	255	60
USCG	ANB 55	18	58	671	255	110
USCG	ANB(X) 34	1	34	230	235	100
USCG	ANB(X) 38	1	38	287	235	100
USCG	ATB 41	3	41	334	255	100
USCG	IMARV 50	1	50	498	255	100
USCG	MLB 47	84	47	440	305	30
USCG	TANB 21 CI	12	21	88	245	100
USCG	TANB 21 SI IB	15	21	88	245	100
USCG	TANB 21 SI OB	3	21	88	245	100
USCG	TANB 23	1	23	105	245	100
USCG	TPSB 22	2	22	97	245	100
USCG	UTB 41	143	41	334	95	263

Service	Vessel Class	No. of Vessels	Vessel Length (ft)	Vessel Wetted Hull Area (ft^2)	Days in Port	Days Underway Within 12 nm
USCG	UTL 13	1	13	35	95	263
USCG	UTL 15	1	15	46	195	150
USCG	UTL 16	1	16	52	195	150
USCG	UTL 17	1	17	58	195	150
USCG	UTL 18	3	18	65	195	150
USCG	UTL 19	1	19	72	195	150
USCG	UTL 20	1	20	80	195	150
USCG	UTL 21	6	21	88	195	150
USCG	UTL 22	5	22	97	195	150
USCG	UTL 23	12	23	105	195	150
USCG	UTL 24	4	24	115	195	150
USCG	UTL 25	4	25	124	195	150
USCG	UTL 26	1	26	134	195	150
USCG	UTL 27	5	27	145	195	150
USCG	UTL 28	1	28	156	195	150
USCG	UTL 36	1	36	258	195	150
USCG	UTM 27	3	27	145	195	150
USCG	UTM 30	1	30	179	195	150